Amendments to the Claims

The invention claimed is:

1. (original) An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing three components of the Earth's magnetic field vector, and for generating output signals representing the three sensed components;

a pitch and roll sensing circuit for measuring the pitch and roll of the magnetic sensor circuit; and

a processing circuit coupled to said magnetic sensor circuit and said pitch and roll sensing circuit for receiving the output signals, compensating the sensed components for the measured pitch and roll, computing a heading of the vehicle as a function of at least two of the compensated sensed components, and generating a heading signal representing the computed heading.

2. (original) The electronic compass system of claim 1, wherein the following formulas are used to compensate the sensed components (Hx, Hy, Hz) for the measured pitch (*pitch*) and roll (*roll*) by performing a coordinate transformation, such that the compensated sensed components (Hex, Hey, Hez) are:

$Hex = Hx*\cos(pitch) - Hy*\sin(roll)\sin(pitch) - Hz*\cos(roll)\sin(pitch)$

$Hey = Hy*\cos(roll) - Hz*\sin(roll)$

$Hez = Hx*\sin(pitch) + Hy*\sin(roll)\cos(pitch) - Hz*\cos(roll)\sin(pitch)$.

3. (original) The electronic compass system of claim 1, wherein said pitch and roll sensing circuit is an accelerometer having output signals converted to an acceleration that varies between -1g and +1g, wherein the output signals are converted into the measured pitch and roll expressed in degrees by:

$pitch = \text{asin}(Ax/1g)$

$roll = \text{asin}(Ay/1g)$.

4. (original) An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components; and

a processing circuit coupled to said magnetic sensor circuit for:

receiving the output signals from said magnetic sensor circuit,

determining a relative strength of the Earth's magnetic field vector,

determining whether too much noise is present in the output signals received from said magnetic sensor circuit as a function of the relative strength of the Earth's magnetic field vector,

if there is not too much noise present in the output signals, computing a heading of the vehicle as a function of the sensed components, and

generating a heading signal representing the computed heading or a prior heading if too much noise is present in the output signals.

5. (original) The electronic compass system of claim 4, wherein said processing circuit determines whether too much noise is present in the output signals received from said magnetic sensor circuit when the variation in the output signals exceeds a threshold noise level.

6. (original) The electronic compass system of claim 5 wherein said processing circuit further determines whether too much noise is present in the output signals received from said magnetic sensor circuit to update data used to calibrate the compass system, said processing circuit does not update the data used to calibrate the compass system when too much noise is present.

7. (original) The electronic compass system of claim 6, wherein said processing circuit:

determines that too much noise is present in the output signals received from said magnetic sensor circuit to update data used to calibrate the compass system when the variation in the output signals exceeds the threshold noise level, and

determines that too much noise is present in the output signals received from said magnetic sensor circuit to update the heading signal when a defined time period has not yet elapsed from when the variation in the output signals last exceeded the threshold noise level.

8. (original) The electronic compass system of claim 7, wherein the time period that must elapse before the heading signal can be updated is set as a function of the strength of the Earth's magnetic field.

9. (original) The electronic compass system of claim 7, wherein the threshold noise level is set as a function of the Earth's magnetic field.

10. (original) The electronic compass system of claim 4, wherein said processing circuit further determines whether too much noise is present in the output signals received from said magnetic sensor circuit to update data used to calibrate the compass system, said processing circuit does not update the data used to calibrate the compass system when too much noise is present.

11. (original) The electronic compass system of claim 10, wherein said processing circuit determines whether too much noise is present in the output signals received from said magnetic sensor circuit to update data used to calibrate the compass system when the variation in the output signals exceeds a threshold noise level.

12. (original) An electronic compass assembly for a vehicle, comprising:

a circuit board defining a plane corresponding to a mounting surface thereof;

a magnetic sensor circuit mounted on said circuit board for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components, wherein said magnetic sensor circuit includes at least two magnetic field sensing elements each having an axis of sensitivity, wherein at least one of said magnetic field sensing elements is positioned such that its axis of sensitivity is oriented in one of the following two orientations: (a) non-perpendicular and non-parallel to the plane of said

circuit board, and (b) non-perpendicular to the axis of sensitivity of another one of said at least two magnetic field sensing elements; and

a processing circuit coupled to said magnetic sensor circuit for receiving the output signals, computing a heading of the vehicle as a function of the sensed components, and generating a heading signal representing the computed heading.

13. (original) The electronic compass assembly of claim 12, wherein said magnetic compass sensor circuit includes three magnetic field sensing elements none of which are perpendicular or parallel to the plane of said circuit board.

14. (previously presented) The electronic compass assembly of claim 12, wherein said magnetic sensor circuit includes three magnetic field sensing elements contained in a common integrated package having a plurality of leads extending therefrom for mounting to said circuit board.

15. (original) The electronic compass assembly of claim 12, wherein said processing circuit performs a coordinate transform to account for the positioning of at least one of said magnetic field sensing elements such that its axis of sensitivity is oriented in one of the following two orientations: (a) non-perpendicular and non-parallel to the plane of said circuit board, and (b) non-perpendicular to the axis of sensitivity of another one of said at least two magnetic field sensing elements.

16. (original) The electronic compass assembly of claim 15, wherein said processing circuit performs a coordinate transform of an original reference frame S having an x-axis, a y-axis, and a z-axis by:

(a) rotation of the original reference frame S by an angle α about the x-axis into a reference frame S' having an x'-axis, a y'-axis, and a z'-axis;

(b) rotation of the reference frame S' by an angle β about the y'-axis into a reference frame S" having an x"-axis, a y"-axis, and a z"-axis; and

(c) rotation of the reference frame S" by an angle γ about the z"-axis into reference coordinate frame S"'.

17. (original) The electronic compass assembly of claim 16, wherein said processing circuit performs the coordinate transform using the following linear equation:

$$\begin{vmatrix} Xm \\ Ym \\ Zm \end{vmatrix} = \begin{vmatrix} \cos(\alpha)\cos(\beta)\cos(\gamma) - \sin(\alpha)s(\gamma) & \cos(\beta)\cos(\gamma)s(\alpha) + \cos(\alpha)\sin(\gamma) & -\cos(\gamma)\sin(\beta) \\ -\cos(\gamma)\sin(\alpha) - \cos(\alpha)c(\beta)\sin(\gamma) & \cos(\alpha)c(\gamma) - \cos(\beta)s(\alpha)\sin(\gamma) & \sin(\beta)\sin(\gamma) \\ \cos(\alpha)\sin(\beta) & \sin(\alpha)\sin(\beta) & \cos(\beta) \end{vmatrix} \begin{vmatrix} Xs \\ Ys \\ Zs \end{vmatrix}$$

18.–49. (canceled)

50. (original) An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components; and

a processing circuit coupled to said magnetic sensor circuit for:

receiving the output signals from said magnetic sensor circuit,

computing a noise level from the output signals received from said magnetic sensor circuit as a function of a root mean square of values derived from the output signals,

determining whether too much noise is present in the output signals received from said magnetic sensor circuit if the noise level exceeds a threshold noise level,

if there is not too much noise present in the output signals, computing a heading of the vehicle as a function of the sensed components, and

generating a heading signal representing the computed heading or a prior heading if too much noise is present in the output signals.

51. (original) The electronic compass system of claim 50, wherein said processing circuit computes second derivatives of the output signals from said compass sensor circuit, and

wherein said processing circuit computes the noise level as a function of the root mean square of the computed second derivatives.

52. (original) An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components; and

a processing circuit coupled to said magnetic sensor circuit for:

receiving the output signals from said magnetic sensor circuit,

computing a noise level from the output signals received from said magnetic sensor circuit as a function of a mean square error of values derived from the output signals,

determining whether too much noise is present in the output signals received from said magnetic sensor circuit if the noise level exceeds a threshold noise level,

if there is not too much noise present in the output signals, computing a heading of the vehicle as a function of the sensed components, and

generating a heading signal representing the computed heading or a prior heading if too much noise is present in the output signals.

53. (original) The electronic compass system of claim 52, wherein said processing circuit computes second derivatives of the output signals from said compass sensor circuit, and wherein said processing circuit computes the noise level as a function of the mean square error of the computed second derivatives.

54.-106. (canceled)